Developing behavioral filters: Some extensions of state-space grids for dyadic data analysis.

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Workshop on Computationally Intensive Modeling of Social Interactions
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~ Outline ~

§1 Geometric Organization

- Filtering Eye Movements
- Emotional Fixations

§2 Region of Interest Analysis

- Defining the Region
- Computing new measures
- Findings
- Substantive Extensions

§1 Geometric Organization of Affect: An Eye-tracking Analogy

(show the clip)

The Data

Relationship-Specific Affect

18 items of emotional experiences specific to the relationship.

Positive	Negative
Emotionally intimate	Sad
Trusted	Blue
Committed	Trapped
Physically intimate	Argumentative
Free	Discouraged
Loved	Doubtful
Happy	Lonely
Loving	Angry
Socially supported	Deceived

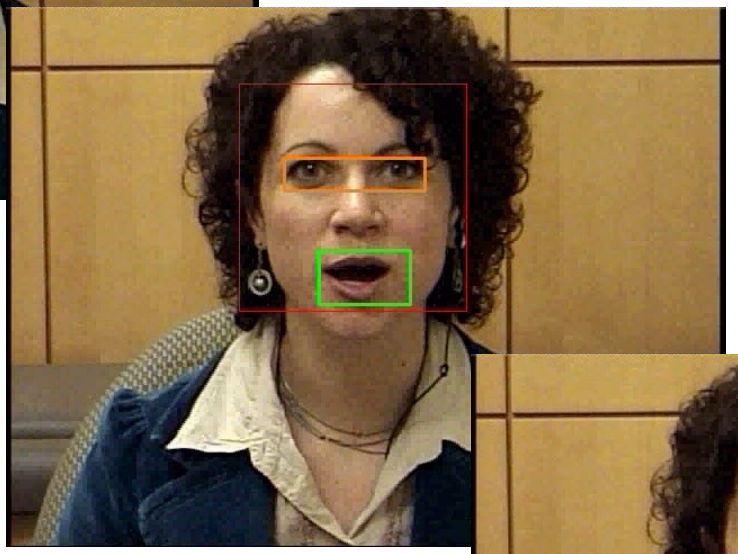
5 point Likert-type scale
1(*very slightly or not at all*)
to 5(*extremely*)

$$R_{change} = \frac{\sigma^2_{person \times day}}{\sigma^2_{person \times day} + \frac{\sigma^2_{Error}}{m}}$$

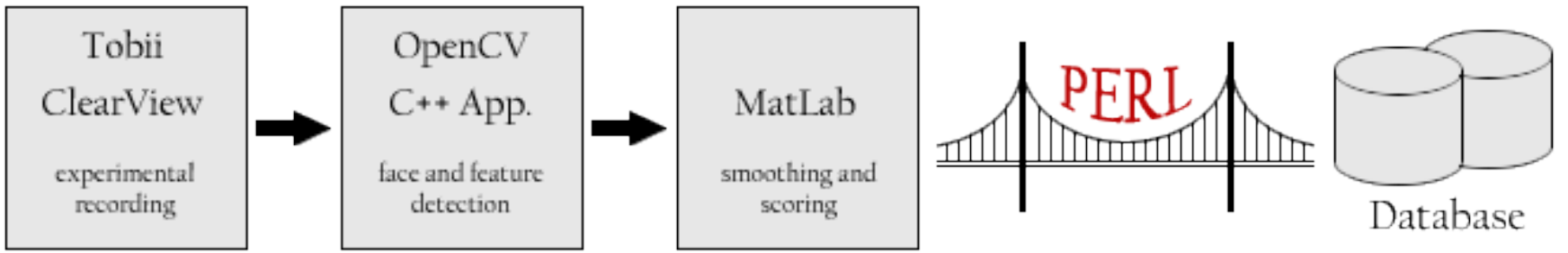
Reliability of change ranged from .82 – .87

Source: Steele, J.S., Ferrer, E., & Nesselroade, J.R. (2013); Cranford, J.A., Shrout, P.E., Iida, M., Rafaeli, E., Yip, T., & Bolger, N. (2006)

Automated scoring of eye-tracking experiments using OpenCV, C/C++, MatLab, & Perl

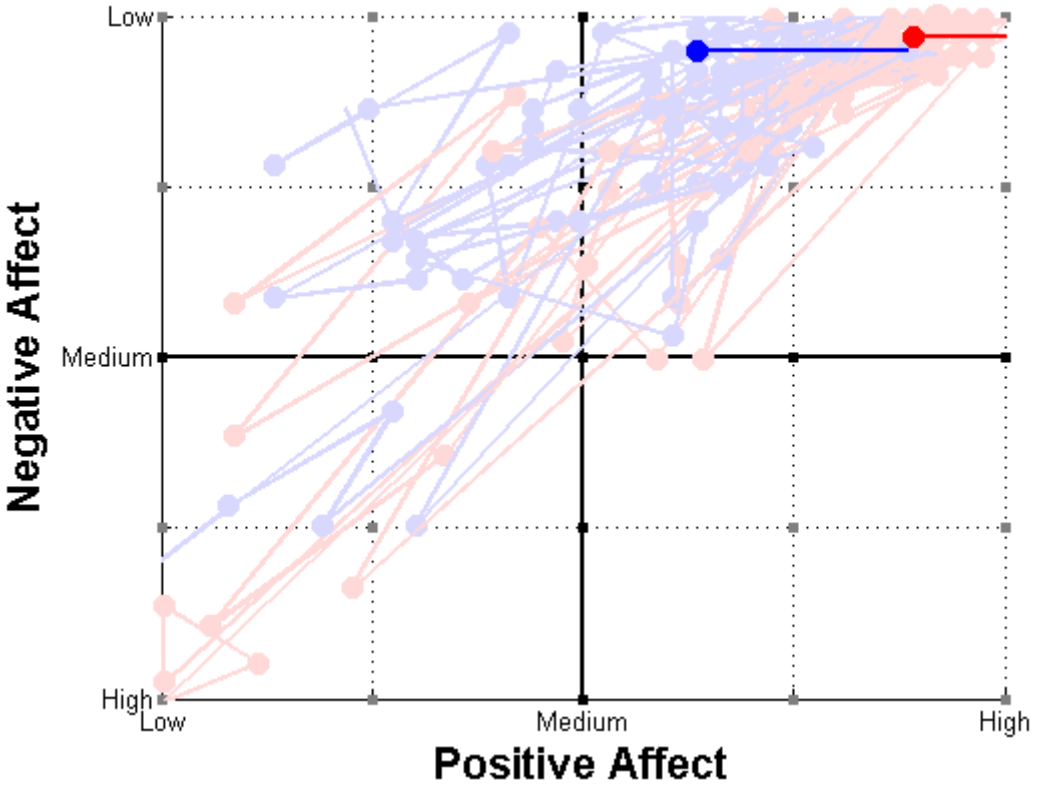


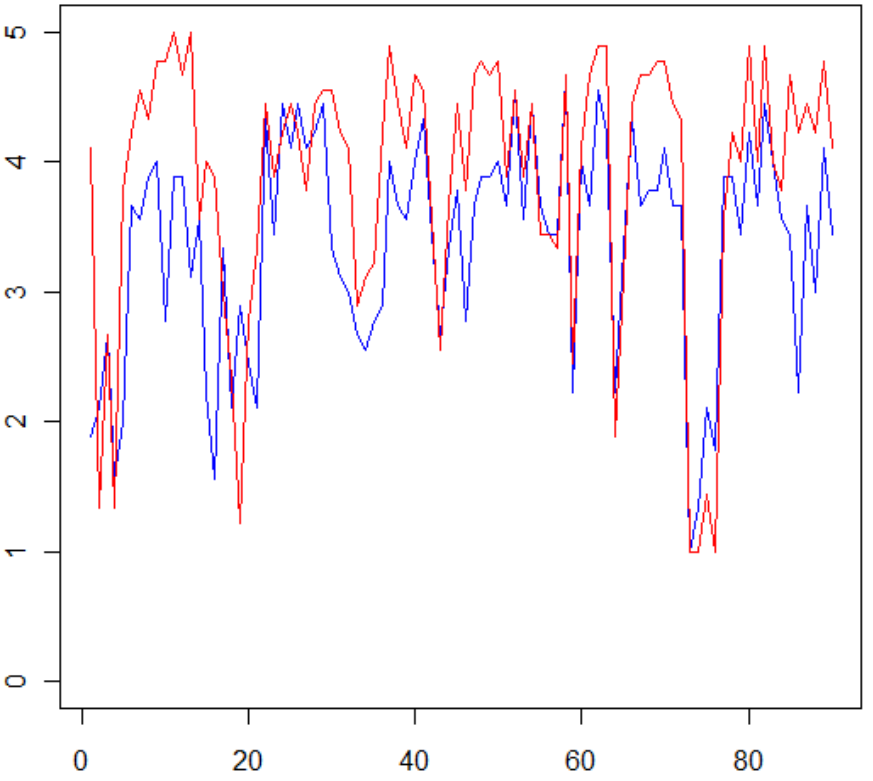
Coded fixation identification algorithm. ICC values Compared to human coders on composite metrics ranged between .77 to .92



(Show video clips)

Fixation Filters: Behavioral Stability





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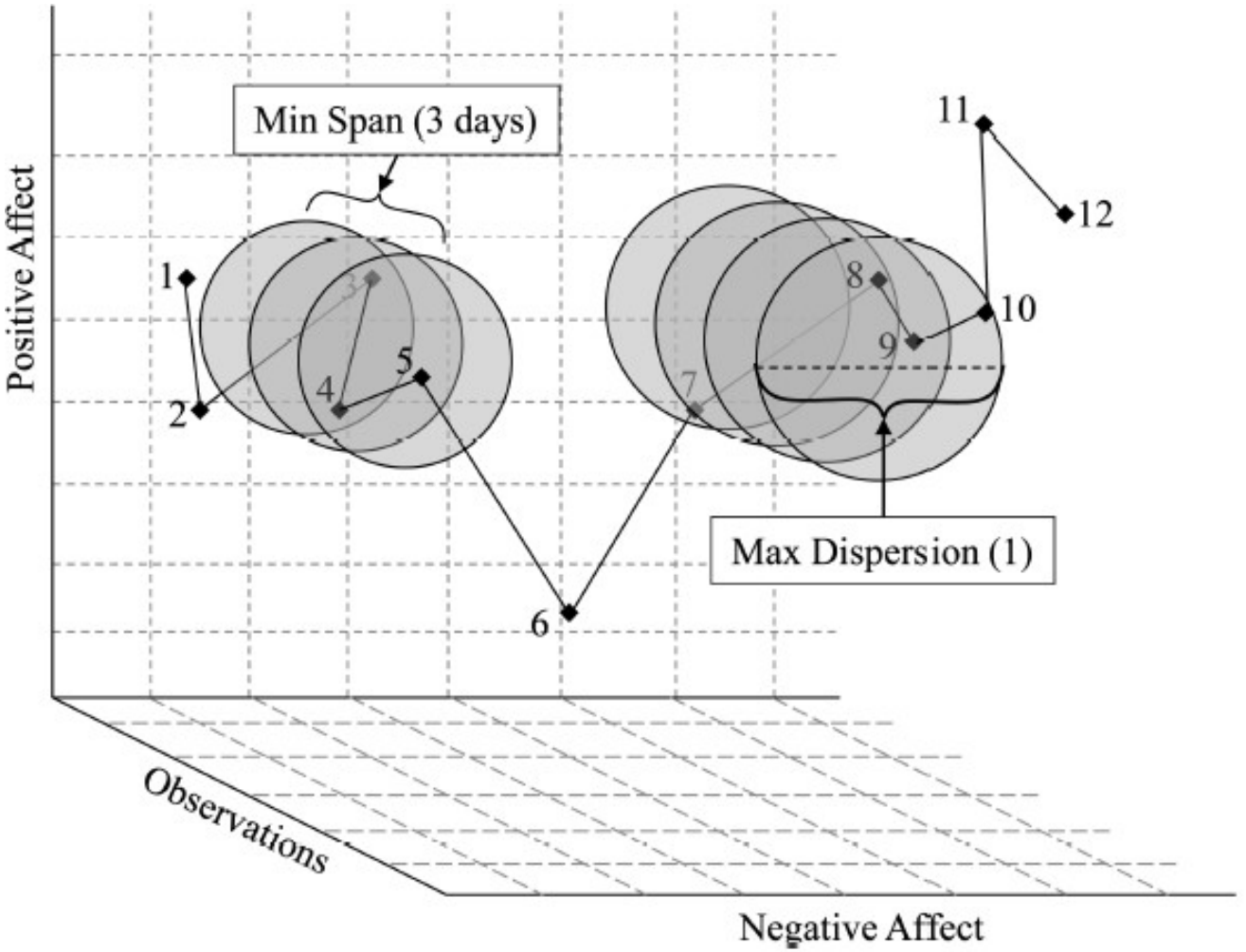
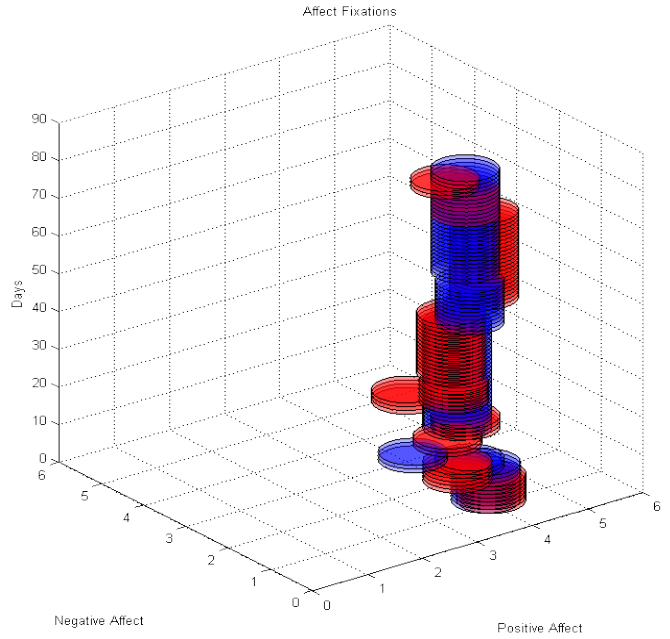
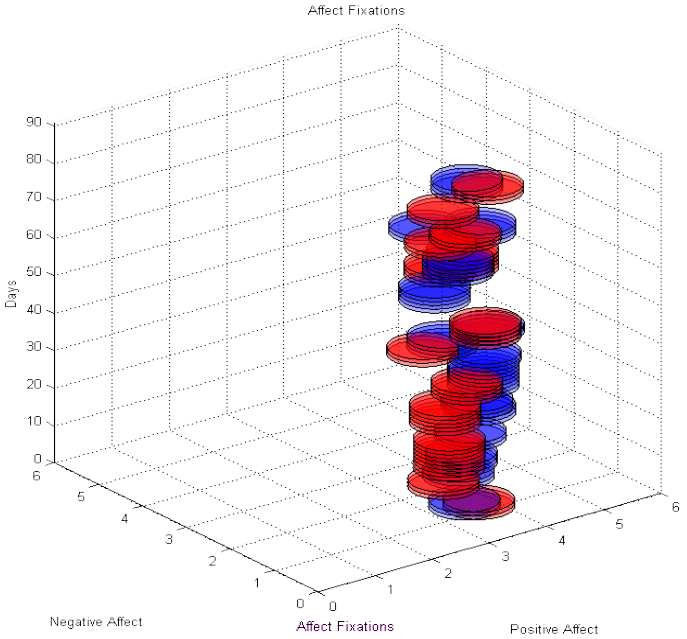


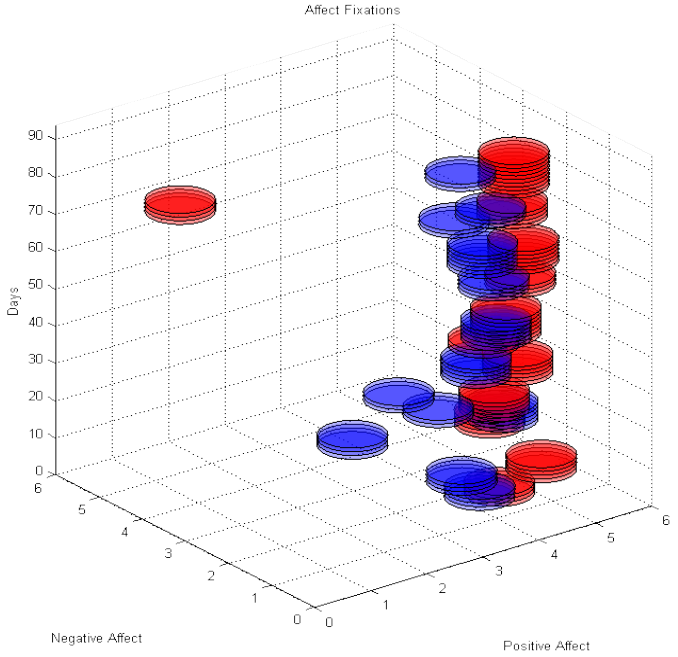
FIGURE 1 Cartesian coordinates of affect and schematic representation of maximum dispersion and minimum duration for the fixation algorithm.

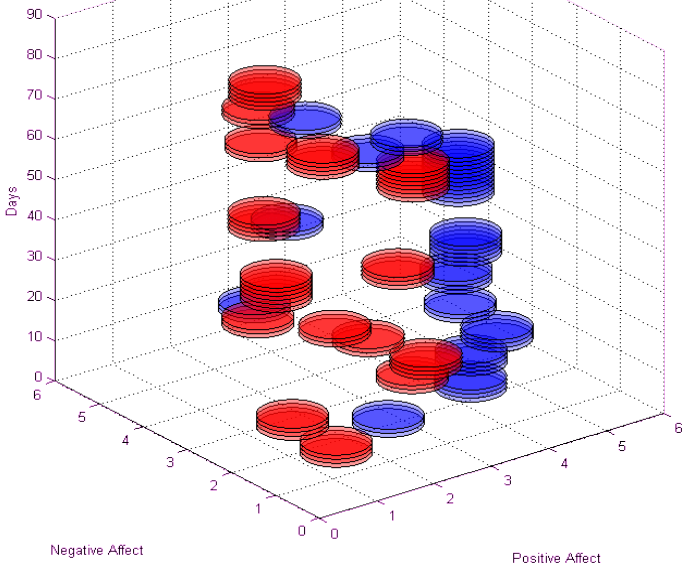
(Show video clips)

Fixation Filters: Behavioral Stability



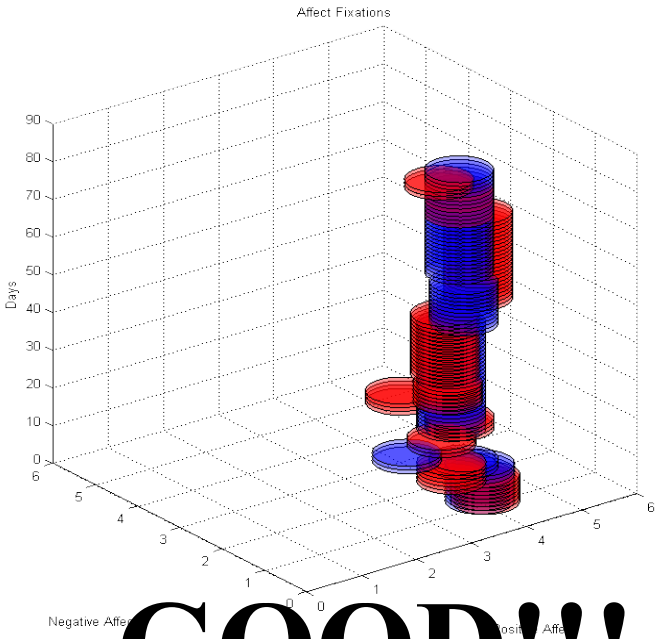




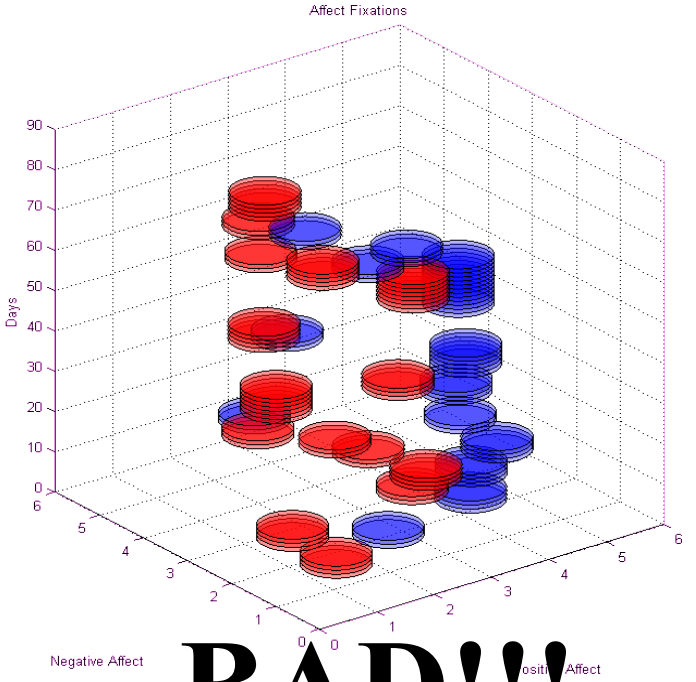


What did we learn?

- The average length (-) and variability (+) of fixations was related to break-up one year later. Even when controlling for age, length of the relationship, and satisfaction.
- Also, variability (+) in where on the negative dimension individuals fixated was associated with break up.



GOOD!!!



BAD!!!

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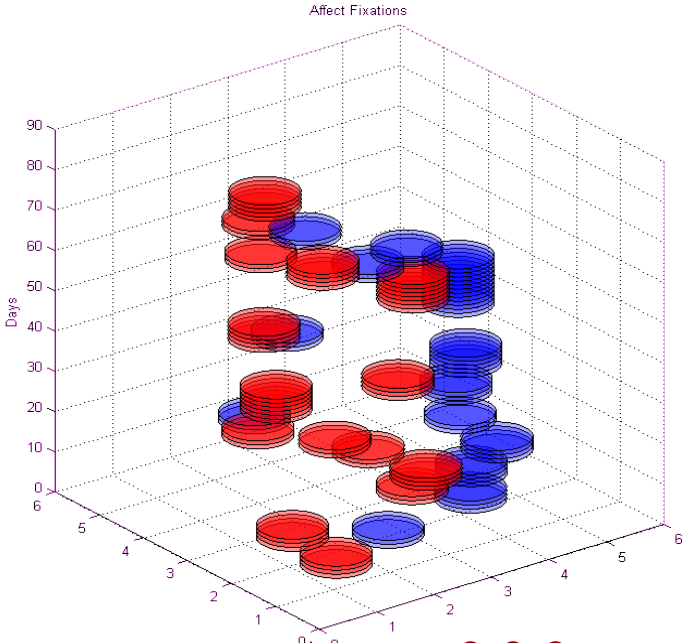


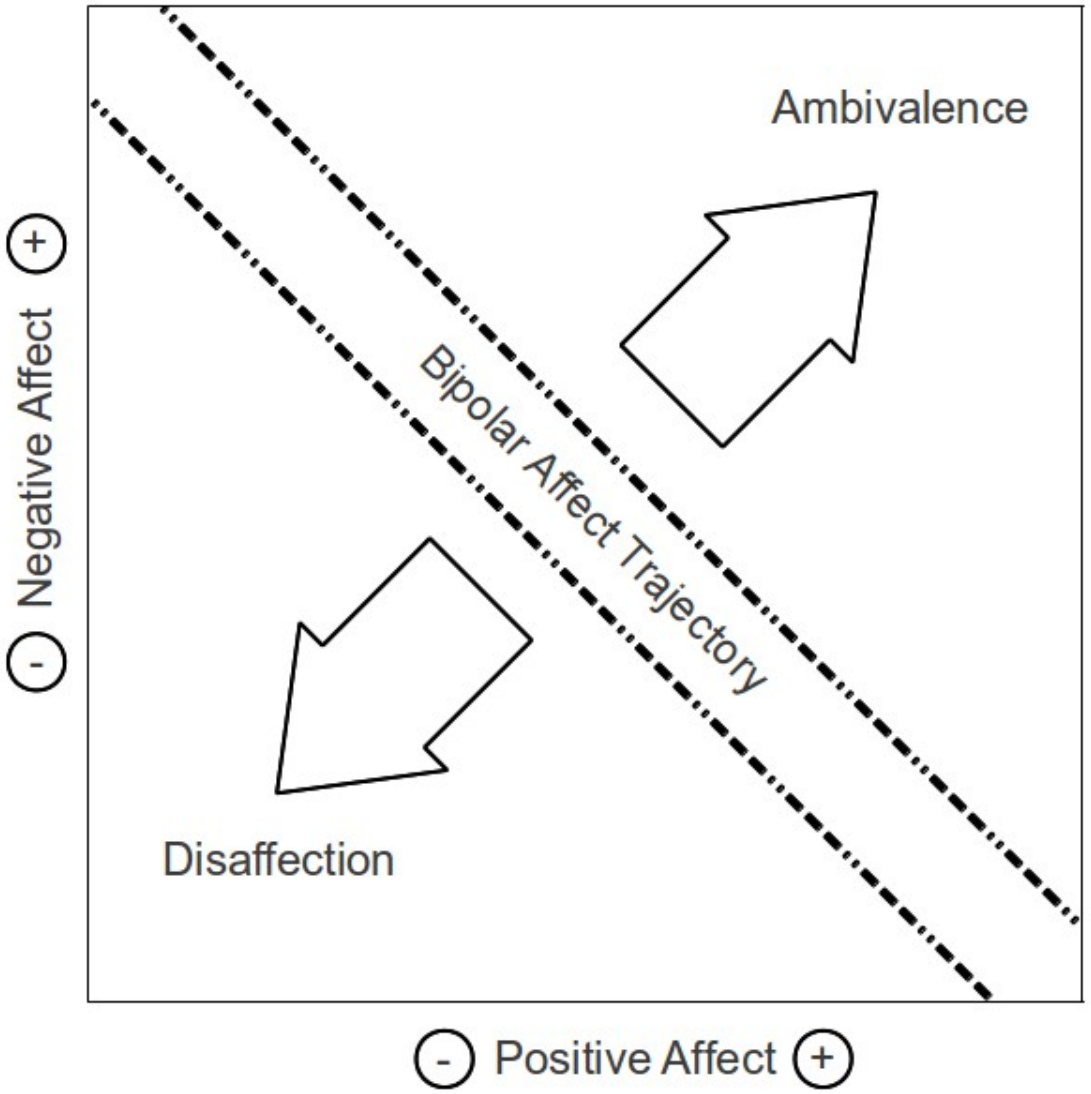
BAD!!!

§2 Region of Interest Analysis: Examining the *Red-Zone*

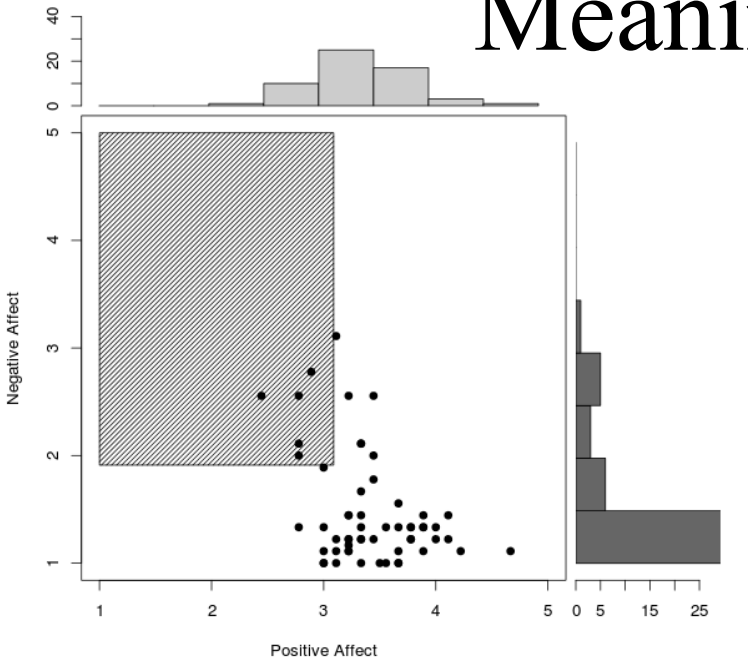
Regions of Interest: Substantively Meaningful Movement

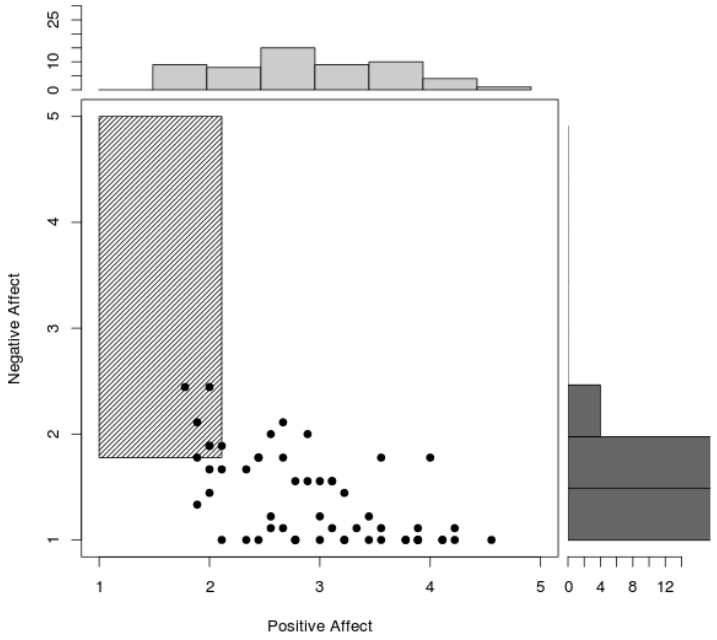
Using our affective plane, it is possible to assign qualitative descriptions to different regions.

Since these data are longitudinal, we can also qualify movements within the plane.



Regions of Interest: Substantively Meaningful Movement





Since different regions have qualitative meaning, we can investigate regions of interest.

We define the upper 20% of Negative affect, and the lower 20% of positive affect as the ***Red-Zone***.

This area may be diagnostic of relationship quality or functioning.

Regions are defined idiographically, since use of the scale can differ per individual.

Regions of Interest: Substantively Meaningful Movement

Here we present data from 186 couples who provided affect ratings from 30 to 97 consecutive days.

Couples involved in a romantic relationship ranging from less than one year up to 38 years in length, and ranged in age from 19.1 to 74.11 years ($M = 34.5$; $SD = 12.6$)

Our four questions about the red-zone:

a) How many red-zone episodes and how long did they last?
b) How much distance between partners when one was in the red-zone?
c) How did individuals enter and exit the red-zone?
d) How large was the affect transition surrounding a red-zone episode?

Movement relative to the ROI

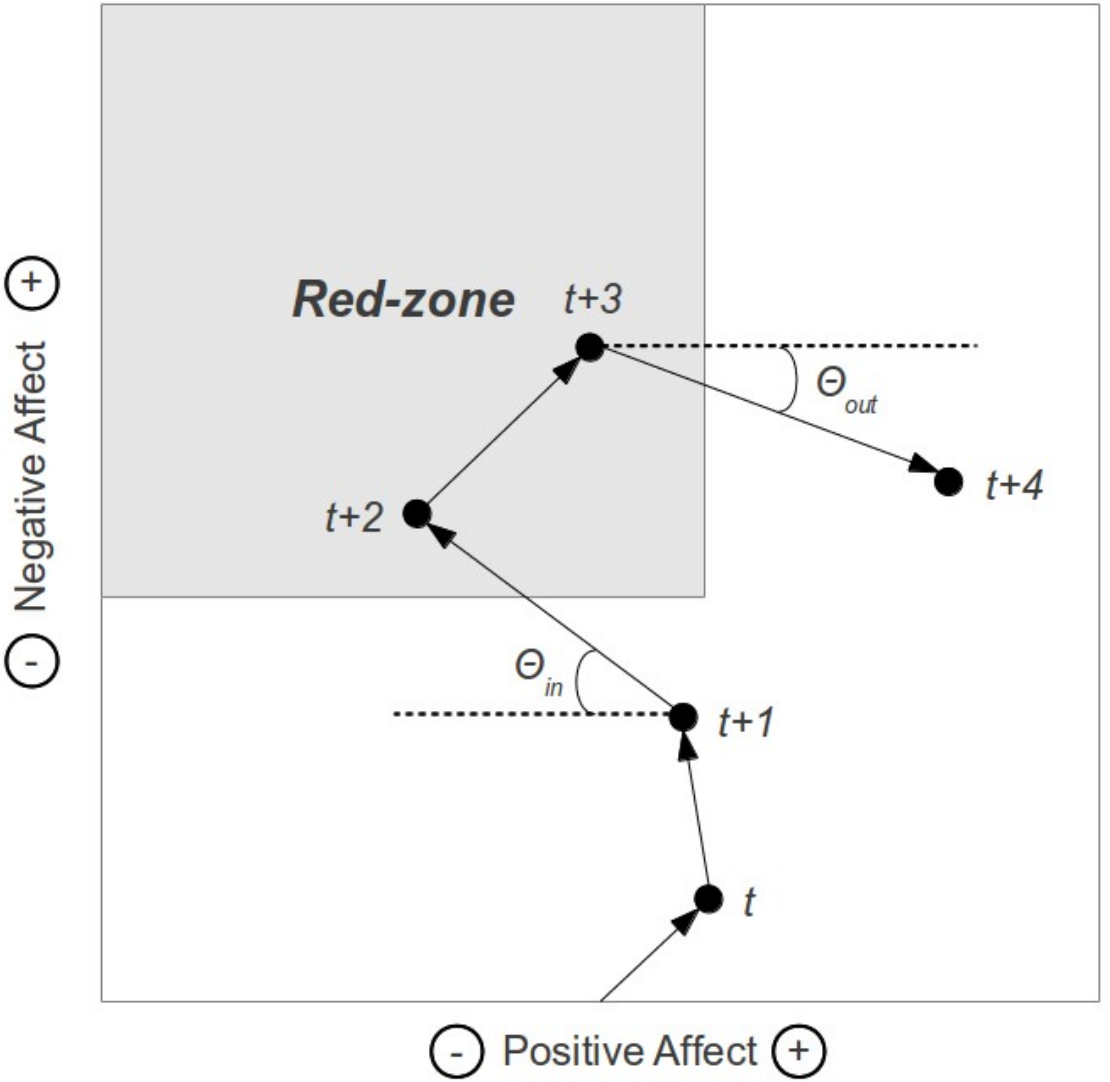
Intra-individual Red-Zone related measures

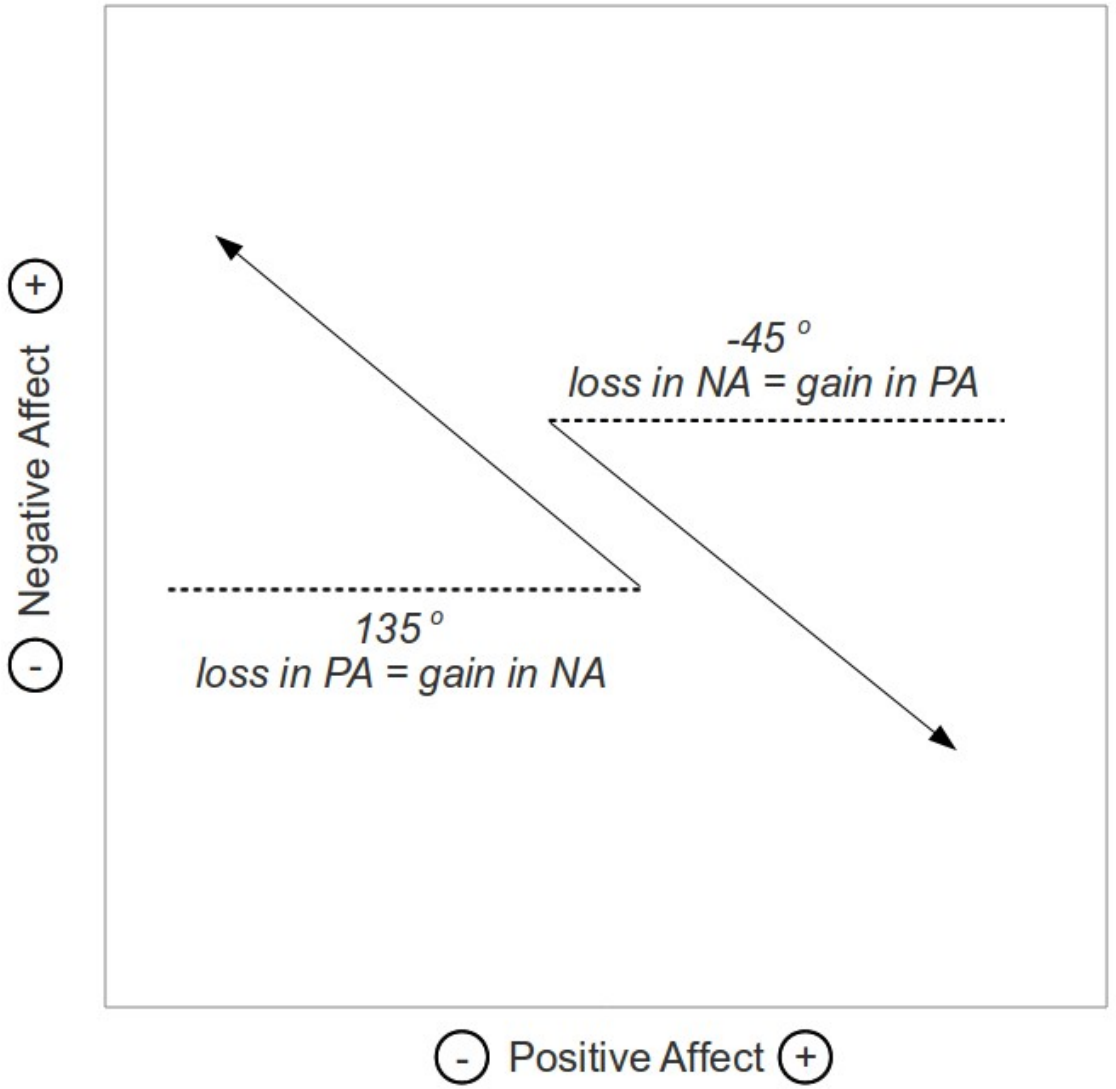
$$angle_t = \tan\left(\frac{NA_t - NA_{t-1}}{PA_t - PA_{t-1}}\right) \times \frac{180^o}{\pi}$$

$$Magnitude_t = \sqrt{(PA_t - PA_{t-1})^2 + (NA_t - NA_{t-1})^2}$$

Inter-individual/intra-dyadic Red-Zone measure

$$Distance_t = \sqrt{(PA_{at} - PA_{bt})^2 + (NA_{at} - NA_{bt})^2}$$


Red-zone
t+3
t+4
t+2
t+1
t
Θout
Θin
+ Negative Affect -
- Positive Affect +


-45 °
loss in NA = gain in PA
135 °
loss in PA = gain in NA
- Negative Affect +
- Positive Affect +

What did we learn?

Sample level models

- Larger distance between partners during RZ episodes is bad for relationship satisfaction (b = -0.563, p = 0.006)
- Large jumps into the RZ is also bad for relationship satisfaction (b = -0.439, p = 0.015)
- This was found while controlling for
  - attachment related avoidance and anxiety
  - age
  - length of the relationship

What did we learn?

Transition Magnitudes (size of jumps)

$$Magnitude[it] \sim \beta_{0i} + \beta_{1i} RZ\ episode[it] + \beta_{2i} Angle[it] + \beta_{3i} Distance[it] + e[it]$$

$$\beta_{0i} \sim \gamma_{00} + \gamma_{01} CLASS + \gamma_{02} MALE + u_{0i}$$
$$\beta_{1i} \sim \gamma_{10} + \gamma_{11} CLASS + \gamma_{12} MALE + u_{1i}$$
$$\beta_{2i} \sim \gamma_{20} + \gamma_{21} CLASS + \gamma_{22} MALE + u_{2i}$$
$$\beta_{3i} \sim \gamma_{30} + \gamma_{31} CLASS + \gamma_{32} MALE + u_{3i}$$

What did we learn?

Transition Magnitudes (size of jumps)

- In general **bigger** jumps into than out of the RZ.
- The **greater** the distance between partners during a RZ the **smaller** the jump *out* of the RZ
- The **greater** the distance between partners before a RZ the **bigger** the jump *into* the RZ
- The more **vertical** the angle of entry the **bigger** the jump *into* the RZ; greater increase in Negative affect than loss in Positive.

What did we learn?

Resulting distance (how close after a jump)

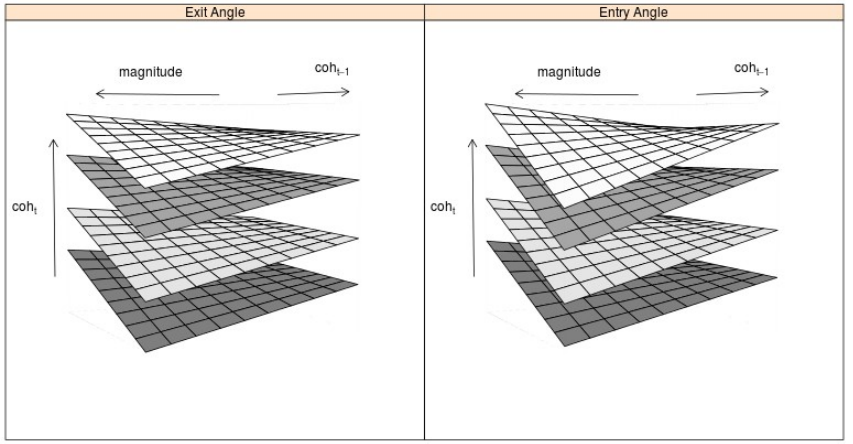
$$Resulting\ Distance[it] \sim \beta_{0i} + \beta_{1i}\, Magnitude[it] + \beta_{2i}\, Angle[it] + \beta_{3i}\, Distance[it] + e[it]$$

$$\beta_{0i} \sim \gamma_{00} + \gamma_{01}\, CLASS + u_{0i}$$
$$\beta_{1i} \sim \gamma_{10} + \gamma_{11}\, CLASS + u_{1i}$$
$$\beta_{2i} \sim \gamma_{20} + u_{2i}$$
$$\beta_{3i} \sim \gamma_{30} + \gamma_{31}\, CLASS + u_{3i}$$

What did we learn?

Resulting distance (how close after a jump)

- Partners are closer after exiting the RZ than upon entering.
- However, the bigger the jump, the bigger the distance between partners, especially for entry into the RZ.
- The bigger the distance prior, the bigger the distance after.
- Angles toward ambivalence resulted in closer partners, this went away when interactions were modeled.
- My first significant 4-way interaction! Still working on this...



What else can we do?

Is this just a proxy for high positive ratings?

- Add in the mean positive and negative affect ratings for the relationship satisfaction models.
- Controlling for these measures, does anything pop up as contributing "above and beyond"?

What else can we do?

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 count	1.00																	
2 len_mean	-0.11	1.00																
3 len_sd	0.00	0.88	1.00															
4 coh_mean	-0.13	-0.06	0.02	1.00														
5 coh_sd	-0.06	-0.06	-0.01	0.73	1.00													
6 in_mean	0.20	0.18	0.21	-0.11	-0.07	1.00												
7 cin_mean	0.17	0.23	0.24	-0.11	-0.12	0.03	1.00											
8 in_sd	0.03	-0.10	-0.09	0.01	-0.07	-0.75	0.24	1.00										
9 out_mean	0.24	0.26	0.30	-0.16	-0.09	0.19	0.46	0.01	1.00									
10 cout_mean	0.24	0.26	0.30	-0.16	-0.09	0.19	0.46	0.01	1.00	1.00								
11 out_sd	-0.13	-0.19	-0.17	-0.03	-0.08	-0.21	-0.13	0.20	-0.22	-0.22	1.00							
12 in_mag_mean	-0.06	-0.14	-0.13	0.20	0.38	-0.01	-0.22	-0.18	-0.24	-0.24	-0.16	1.00						
13 in_mag_sd	0.01	-0.16	-0.15	0.20	0.34	-0.05	-0.19	-0.04	-0.13	-0.13	-0.08	0.67	1.00					
14 out_mag_mean	-0.06	-0.12	-0.12	0.22	0.39	-0.02	-0.25	-0.13	-0.16	-0.16	-0.21	0.81	0.59	1.00				
15 out_mag_sd	0.01	-0.06	-0.05	0.14	0.32	0.00	-0.17	-0.09	-0.10	-0.10	-0.04	0.50	0.52	0.65	1.00			
16 relsat	0.09	0.07	0.04	-0.29	-0.28	0.04	0.14	0.05	0.17	0.17	-0.01	-0.16	-0.10	-0.09	0.00	1.00		
17 meanPos	0.05	0.09	0.06	-0.43	-0.33	0.11	0.13	0.03	0.11	0.11	-0.03	-0.14	-0.09	-0.10	-0.03	0.44	1.00	
18 meanNeg	-0.19	-0.08	-0.10	0.48	0.38	-0.22	-0.32	-0.01	-0.33	-0.33	0.00	0.45	0.27	0.39	0.27	-0.21	-0.36	1.00

What else can we do?

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5 coh_sd	-0.06	-0.06	-0.01	0.73	1.00													
6 in_mean	0.20	0.18	0.21	-0.11	-0.07	1.00												
7 cin_mean	0.17	0.23	0.24	-0.11	-0.12	0.03	1.00											
8 in_sd	0.03	-0.10	-0.09	0.01	-0.07	-0.75	0.24	1.00										
9 out_mean	0.24	0.26	0.30	-0.16	-0.09	0.19	0.46	0.01	1.00									
10 cout_mean	0.24	0.26	0.30	-0.16	-0.09	0.19	0.46	0.01	1.00	1.00								
11 out_sd	-0.13	-0.19	-0.17	-0.03	-0.08	-0.21	-0.13	0.20	-0.22	-0.22	1.00							
12 in_mag_mean	-0.06	-0.14	-0.13	0.20	0.38	-0.01	-0.22	-0.18	-0.24	-0.24	-0.1	1.00						
13 in_mag_sd	0.01	-0.16	-0.15	0.20	0.34	-0.05	-0.19	-0.04	-0.13	-0.13	-0.0	0.67	1.00					
14 out_mag_mean	-0.06	-0.12	-0.12	0.22	0.39	-0.02	-0.25	-0.13	-0.16	-0.16	-0.2	0.81	0.59	1.00				
15 out_mag_sd	0.01	-0.06	-0.05	0.14	0.32	0.00	-0.17	-0.09	-0.10	-0.10	-0.0	0.50	0.52	0.65	1.00			
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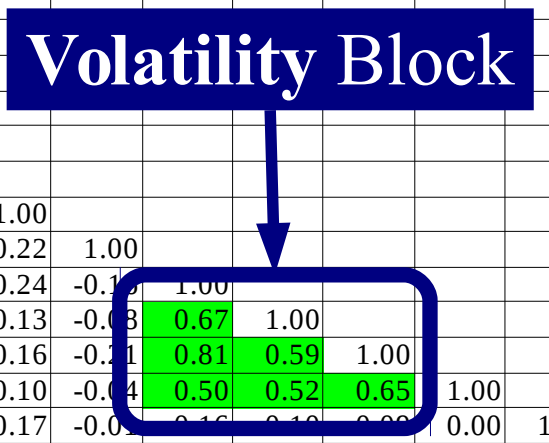
18 meanNeg	-0.19	-0.08	-0.10	0.48	0.38	-0.22	-0.32	-0.01	-0.33	-0.33	0.00	0.45	0.27	0.39	0.27	-0.21	-0.36	1.00



This block comprises measures related to transition magnitude, the distance traveled during a jump into or out of the red-zone

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6 in_mean	0.2																	
7 cin_mean	0.1																	
8 in_sd	0.03	-0.10	-0.09	0.01	-0.07	-0.75	0.24	1.00										
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12 in_mag_mean	-0.06	-0.14	-0.13	0.1	0.38	0.01	-0.22	-0.18	-0.24	-0.24	-0.1	1.00						
13 in_mag_sd	0.01	-0.16	-0.15	0.1	0.34	0.05	-0.19	-0.04	-0.13	-0.13	-0.0	0.67	1.00					
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15 out_mag_sd	0.01	-0.06	-0.05	0.1	0.32	0.00	-0.17	-0.09	-0.10	-0.10	-0.0	0.50	0.52	0.65	1.00			
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Variance in Distance

Volatility Block

Distance represent
Distance between partners.

What else can we do?

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Variance in Distance

Volatility Block

Mean Negative

What else can we do?

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 count	1.00																	
2 len_mean	-0																	
3 len_sd	0																	
4 coh_mean	-0																	
5 coh_sd	-0																	
6 in_mean	0																	
7 cin_mean	0.																	
8 in_sd	0.03	-0.10	-0.09	0.01	-0.07	-0.75	0.24	1.00										
9 out_mean	0.24	0.26	0.30	-0.16	-0.09	0.19	0.46	0.01	1.00									
10 cout_mean	0.24	0.26	0.30	-0.16	-0.09	0.19	0.46	0.01	1.00	1.00								
11 out_sd	-0.13	-0.19	-0.	-0.	-0.	0.21	-0.13	0.20	-0.22	-0.22	1.00							
12 in_mag_mean	-0.06	-0.14	-0.	0.20	0.38	0.01	-0.22	-0.18	-0.24	-0.24	-0.16	1.00						
13 in_mag_sd	0.01	-0.16	-0.	0.20	0.34	0.05	-0.19	-0.04	-0.13	-0.13	-0.08	0.67	1.00					
		0.12	-0.	0.22	0.39	0.02	-0.25	-0.13	-0.16	-0.16	-0.21	0.81	0.59	1.00				
		0.06	-0.	0.14	0.32	0.00	-0.17	-0.09	-0.10	-0.10	-0.04	0.50	0.52	0.65	1.00			
		0.07	0.			0.04	0.14	0.05	0.17	0.17	-0.01	-0.16	-0.10	-0.09	0.00	1.00		
17 meanPos		0.09	0.	-0.43	-0.33	.11	0.13	0.03	0.11	0.11	-0.03	-0.14	-0.09	-0.10	-0.03	0.44	1.00	
18 meanNeg	-0.19	-0.08	-0.	0.48	0.38	.22	-0.32	-0.01	-0.33	-0.33	0.00	0.45	0.27	0.39	0.27	-0.21	-0.36	1.00

Mean and Variance in Distance

Mean Positive

Mean Negative

What else can we do?

Outcome: Relationship satisfaction

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	4.482e+00	4.944e-01	9.064	< 2e-16	***
len_tot	5.806e-03	2.646e-02	0.219	0.8265	
e_count	-9.702e-03	4.476e-02	-0.217	0.8286	
e_len_mean	1.652e-02	1.781e-01	0.093	0.9261	
e_len_sd	-6.330e-02	1.202e-01	-0.527	0.5989	
e_dis_mean	-1.258e-01	2.121e-01	-0.593	0.5534	
e_dis_sd	-7.372e-01	3.883e-01	-1.898	0.0586	.
e_cin_mean	1.909e-03	3.076e-03	0.621	0.5354	
e_in_sd	-7.573e-05	1.012e-03	-0.075	0.9404	
e_cout_mean	3.819e-03	2.878e-03	1.327	0.1856	
e_out_sd	-2.650e-04	3.053e-03	-0.087	0.9309	
e_in_mag_mean	-3.336e-01	1.770e-01	-1.885	0.0605	.
e_in_mag_sd	1.714e-01	1.989e-01	0.862	0.3895	
e_out_mag_mean	2.622e-01	1.883e-01	1.392	0.1649	
e_out_mag_sd	1.480e-01	2.124e-01	0.697	0.4866	
meanPos	4.848e-01	7.887e-02	6.146	2.66e-09	***
meanNeg	1.125e-01	1.873e-01	0.601	0.5485	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7476 on 286 degrees of freedom
Multiple R-squared: 0.269, Adjusted R-squared: 0.2281
F-statistic: 6.577 on 16 and 286 DF, p-value: 1.198e-12

What else can we do?

Outcome: Relationship satisfaction

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	4.9772492	0.5822756	8.548	1.13e-15	***
len_tot	0.0199500	0.0347147	0.575	0.5660	
e_count	-0.0213431	0.0566336	-0.377	0.7066	
e_len_mean	-0.0334046	0.2149159	-0.155	0.8766	
e_len_sd	-0.0547681	0.1529354	-0.358	0.7206	
e_dis_mean	-0.1705893	0.2251420	-0.758	0.4493	
e_dis_sd	-0.5403848	0.3959628	-1.365	0.1735	
e_cin_mean	0.0009201	0.0031972	0.288	0.7738	
e_in_sd	-0.0001845	0.0010264	-0.180	0.8575	
e_cout_mean	0.0034993	0.0029472	1.187	0.2362	
e_out_sd	0.0004421	0.0031631	0.140	0.8889	
e_in_mag_mean	-0.3741143	0.1809083	-2.068	0.0396	*
e_in_mag_sd	0.2578119	0.2044732	1.261	0.2085	
e_out_mag_mean	0.2093175	0.1914848	1.093	0.2754	
e_out_mag_sd	0.1981483	0.2170521	0.913	0.3621	
meanPos	0.4066230	0.0890211	4.568	7.66e-06	***
meanNeg	0.0292635	0.1917240	0.153	0.8788	
AvoidanceT1	-0.1698315	0.0674487	-2.518	0.0124	*
AnxietyT1	0.1041760	0.0480286	2.169	0.0310	*
AgeT1	-0.0020065	0.0102633	-0.196	0.8452	
YrsinRelationshipT1	-0.0070224	0.0157933	-0.445	0.6570	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7384 on 257 degrees of freedom
Multiple R-squared: 0.2928, Adjusted R-squared: 0.2377
F-statistic: 5.32 on 20 and 257 DF, p-value: 3.259e-11

What else can we do?

```
Outcome: Relationship Status (0 = together, 1 = apart)

                    Estimate Std. Error z value Pr(>|z|)
(Intercept)         2.744931   1.600393   1.715  0.08632 .
len_tot            -0.039400   0.120978  -0.326  0.74467
e_count            -0.138522   0.186910  -0.741  0.45862
e_len_mean         -0.653461   0.641384  -1.019  0.30828
e_len_sd            0.602965   0.404454   1.491  0.13601
e_dis_mean         -1.140456   0.717560  -1.589  0.11198
e_dis_sd            2.308076   1.274582   1.811  0.07016 .
e_cin_mean          0.002250   0.009292   0.242  0.80863
e_in_sd            -0.000656   0.003294  -0.199  0.84212
e_cout_mean        -0.005681   0.008570  -0.663  0.50739
e_out_sd           -0.002495   0.009475  -0.263  0.79228
e_in_mag_mean       0.637458   0.488294   1.305  0.19173
e_in_mag_sd        -0.856377   0.598188  -1.432  0.15225
e_out_mag_mean      0.268718   0.523648   0.513  0.60784
e_out_mag_sd       -0.459850   0.632234  -0.727  0.46702
meanPos            -0.683913   0.249288  -2.743  0.00608 **
meanNeg            -0.607443   0.565762  -1.074  0.28297
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

    Null deviance: 369.82  on 396  degrees of freedom
Residual deviance: 338.43  on 380  degrees of freedom
AIC: 372.43
```

What else can we do?

Outcome: Relationship Status (0 = together, 1 = apart)

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	7.7681996	2.6093490	2.977	0.00291	**
len_tot	0.1209568	0.1518259	0.797	0.42564	
e_count	-0.2522886	0.2328290	-1.084	0.27855	
e_len_mean	-0.7163622	0.9005970	-0.795	0.42636	
e_len_sd	0.4061797	0.5282320	0.769	0.44193	
e_dis_mean	-1.1046682	0.7363512	-1.500	0.13356	
e_dis_sd	2.5915207	1.3677013	1.895	0.05812	.
e_cin_mean	0.0004268	0.0100838	0.042	0.96624	
e_in_sd	0.0007625	0.0034819	0.219	0.82667	
e_cout_mean	-0.0045442	0.0088936	-0.511	0.60938	
e_out_sd	-0.0054179	0.0101552	-0.534	0.59368	
e_in_mag_mean	0.4681447	0.5148963	0.909	0.36324	
e_in_mag_sd	-0.6742102	0.6296977	-1.071	0.28431	
e_out_mag_mean	0.3252326	0.5498200	0.592	0.55417	
e_out_mag_sd	-0.8936792	0.6713618	-1.331	0.18314	
meanPos	-0.8843741	0.2818868	-3.137	0.00170	**
meanNeg	-0.7433291	0.5971834	-1.245	0.21323	
AvoidanceT1	0.2120776	0.2008864	1.056	0.29110	
AnxietyT1	-0.2138485	0.1691120	-1.265	0.20604	
AgeT1	-0.1835189	0.0807184	-2.274	0.02299	*
YrsinRelationshipT1	-0.1429082	0.1164072	-1.228	0.21958	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Null deviance: 366.68 on 388 degrees of freedom
Residual deviance: 306.11 on 368 degrees of freedom
AIC: 348.11

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Thank You

for your attention and your time